## ABSTRACT

An apparatus and method to enhance oxygen delivery to tissue encapsulated in an immunobarrier device. In one embodiment, *in situ* electrochemical oxygen generation by electrolysis of water into oxygen and hydrogen supplies oxygen to the tissue. In one embodiment a thin, multilayer sheet electrolyzer is enclosed in silicone rubber membranes permeable to gas and water vapor but not liquids. The anode side of the electrolyzer is in contact with one face of the device. Water vapor diffuses into the electrolyzer, decomposes at the anode, and oxygen diffuses back through the membrane to the implanted tissue, thus providing a continuous supply of water, continuous diffusion of $O_2$ and $H_2$ out of the electrolyzer, and exclusion of biological components that might contaminate the electrolyzer.

**Table 1. Values of important parameters in analyzed experiments**

| Parameters | Experiments | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Figure Number | 7a | 7a | 7c | 7d | 7f | 9a | 9b | 9g | 9h |
| Culture Time, t (d) | 0 | 0 | 2 | 2 | 6 | 2 | 2 | 3 | 3 |
| Oxygen Flux, N ($mol/cm^2 \cdot s \times 10^{10}$) | 0 [a] | 3.7 [a] | 0 | 3.7 | 3.7 | 0 | 0.50 | 0 | 0.70 |
| Tissue Thickness, L (μm) | 40 | 40 | 50 | 70 | 100 | 30 | 25 | 25 | 75 |
| Tissue Volume Fraction, 1 - ε | 0.52 | 0.52 | 0.53 | 0.69 | 0.60 | 0.74 | 0.78 | 0.76 | 0.70 |
| Oxygen Consumption Rate, V ($mol/cm^3 \cdot s \times 10^8$) | 1.4 | 1.4 | 1.5 | 1.9 | 1.7 | 2.0 | 2.1 | 2.1 | 1.9 |
| Oxygen Permeability, Dα ($mol/cm \cdot mmHg \cdot s \times 10^{14}$) | 2.2 | 2.2 | 2.1 | 1.8 | 2.0 | 1.7 | 1.6 | 1.7 | 1.8 |
| Tissue Thickness Supportable from Electrolyzer, $L_e$ (μm) | 0 | 250 | 0 | 190 | 220 | 0 | 23 | 0 | 37 |
| Tissue Thickness Supportable from Medium, $L_m$ (μm) | 140 | 140 | 140 | 110 | 130 | 110 | 100 | 100 | 110 |
| Interface P at x = L/2, $P_{Se}$ (mmHg) | 116 | 313 | 108 | 340 | 356 | 115 | 144 | 120 | 115 |
| Interface P at x = - L/2, $P_{Sm}$ (mmHg) | 122 | 250 | 116 | 224 | 212 | 121 | 141 [b] | 124 | 116 |
| Minimum P, $P_{min}$ (mmHg) | --- | --- | --- | --- | --- | --- | 141 [b] | --- | 108 |

For all examples, $P_m = 142$ mm Hg, $R_{ext} = 3.5 \times 10^{11}$ mm Hg/($mol/cm^2 \cdot s$), $\delta = 50$, $L_{M2} = 15$, and $L_{M1} = 30$ μm, $(D\alpha)_{med} = 3.5$, $(D\alpha)_{M2} = 2.8$, and $(D\alpha)_{M1} = 2.0 \times 10^{-14}$ $mol/cm \cdot mmHg \cdot s$, $D_{med} = 2.8 \times 10^{-5}$ $cm^2/s$, $\alpha_{med} = 1.3 \times 10^{-9}$ $mol/cm^3 \cdot mmHg$, $Vmax = 2.76 \times 10^{-8}$ $mol/cm^3 \cdot s$, $P_c = 0.1$ mm Hg, and $Km = 0.44$ mm Hg.
Calculations were carried out with three or more digits, but all parameter results, except for partial pressures, were rounded to two.

[a] The results at t = 0 correspond to the hypothetical oxygen profiles in the absence and presence of an imposed oxygen flux, respectively.

[b] $P_{Sm} - P_{min} \ll 0.5$ mm Hg